

## CONTENTS

## SINGLE-JUNCTION THIN FILM SOLAR CELLS

Criteria for the design of high efficiency thin film solar cells: theory and practice	1
A. Rothwarf (Philadelphia, PA, U.S.A.)	
Improving the performance of amorphous silicon photovoltaic modules	15
D. E. Carlson, R. R. Arya, A. Catalano, R. V. D'Aiello, C. R. Dickson, J. O'Dowd and R. S. Oswald (Newton, PA, U.S.A.)	
Structural characterization of amorphous silicon and germanium	19
R. Tsu (Golden, CO, U.S.A.)	
Long-term stability of amorphous silicon solar cells and modules	25
E. Eser, K. R. Ramaprasad, H. Volltrauer, F. Ramos, S. C. Gau and R. Vos (Princeton, NJ, U.S.A.)	
Fundamental processes in sputtering of relevance to the fabrication of thin film solar cells	41
J. A. Thornton (Urbana, IL, U.S.A.)	
On the effect of stoichiometry and oxygen on the properties of CuInSe <sub>2</sub> thin films and devices	55
R. Noufi, R. C. Powell and R. J. Matson (Golden, CO, U.S.A.)	
Low cost methods for the production of semiconductor films for CuInSe <sub>2</sub> /CdS solar cells	65
V. K. Kapur, B. M. Basol and E. S. Tseng (Inglewood, CA, U.S.A.)	
Thin film cadmium telluride solar cells	73
T. L. Chu, S. S. Chu, S. T. Ang and M. K. Mantravadi (Dallas, TX, U.S.A.)	

## SINGLE-CRYSTAL SINGLE-JUNCTION SOLAR CELLS

Material considerations for high efficiency silicon solar cells	81
T. F. Ciszek (Golden, CO, U.S.A.)	
II-VI and I-III-VI <sub>2</sub> alloy crystals for photovoltaic applications	99
K. J. Bachmann, B. Abid, H. Goslawsky, K. Y. Lay and H. Neff (Raleigh, NC, U.S.A.)	

## MATERIALS FOR MULTIJUNCTION SOLAR CELLS

Vacuum chemical epitaxial growth of III-V materials for multi-band-gap solar cells	109
P. S. McLeod, L. M. Fraas, L. D. Partain and J. A. Cape (Richmond, CA, U.S.A.)	
Evidence for microstructure in glow discharge hydrogenated amorphous Si-C alloys	117
A. H. Mahan, P. Raboisson, D. L. Williamson and R. Tsu (Golden, CO, U.S.A.)	

## MULTIJUNCTION SOLAR CELLS

Device aspects of multijunction photovoltaic module research	127
K. W. Mitchell (Chatsworth, CA, U.S.A.)	

## POSTER OVERVIEWS

Auger line shape analysis of hydrogenated amorphous silicon	135
N. A. Burnham, A. B. Swartzlander, A. J. Nelson and L. L. Kazmerski (Golden, CO, U.S.A.)	
Continuous-mode fabrication of amorphous silicon solar cells on polyimide substrates	141
G. D. Vernstrom, R. L. Jacobson, R. K. Westerberg and F. R. Jeffrey (St. Paul, MN, U.S.A.)	
Gas and surface processes leading to hydrogenated amorphous silicon films	147
A. Gallagher and J. Scott (Boulder, CO, U.S.A.)	

High efficiency amorphous alloy solar cells prepared by mercury-sensitized photochemical vapor deposition of disilane . . . . .	153
A. E. Delahoy (Princeton, NJ, U.S.A.)	
Improvements in the disilane plasma deposition of hydrogenated amorphous silicon solar cells . . . . .	167
P. E. Vanier (Upton, NY, U.S.A.) and F.-C. Su (Stony Brook, NY, U.S.A.)	
Laser-induced chemical vapor deposition of hydrogenated amorphous silicon: photovoltaic devices and material properties . . . . .	177
H. M. Branz, L. K. Liem, C. J. Harris, S. Fan, J. H. Flint, D. Adler and J. S. Haggerty (Cambridge, MA, U.S.A.)	
Optical absorption and disorder in hydrogenated amorphous Si-Ge and Si-C alloy systems . . . . .	189
R. Tsu, P. Menna and A. H. Mahan (Golden, CO, U.S.A.)	
Preparation of solar-grade amorphous silicon from fluorinated silanes . . . . .	195
U. C. Pernisz, K. G. Sharp, L. Tarhay and J. J. D'Errico (Midland, MI, U.S.A.)	
Temperature-dependent photoconductivity and light-induced changes in a-Si <sub>1-x</sub> -Ge <sub>x</sub> :H alloys . . . . .	205
J. P. Xi, T. J. McMahon, A. H. Mahan and R. Tsu (Golden, CO, U.S.A.)	
Preparation of CuInSe <sub>2</sub> and CuInS <sub>2</sub> films by reactive annealing in H <sub>2</sub> Se or H <sub>2</sub> S . . . . .	215
C. D. Lokhande and G. Hodes (Rehovot, Israel)	
Preliminary results on CuInSe <sub>2</sub> /ZnSe solar cells using reactively sputter-deposited ZnSe . . . . .	225
A. Nouhi and R. J. Stirn (Pasadena, CA, U.S.A.)	
Photocollection efficiency of GaAs/AlAs/GaAs p <sup>+</sup> -i-n and n <sup>+</sup> -i-p photodiodes	233
M. R. Melloch, C. P. McMahon, M. S. Lundstrom, J. A. Cooper, Jr. and Q.-D. Qian (West Lafayette, IN, U.S.A.)	
Patterned germanium tunnel junctions for multijunction monolithic cascade solar cells	241
P. K. Chiang, M. L. Timmons and J. A. Hutchby (Research Triangle Park, NC, U.S.A.)	
Reproducible integration of multijunction cascade cell components . . . . .	253
C. R. Lewis, C. W. Ford, G. F. Virshup, B. A. Arau, R. T. Green and J. G. Werthen (Palo Alto, CA, U.S.A.)	
Influence of drift field on n-i-p solar cell performance . . . . .	263
A. Y. Ali and K. W. Böer (Newark, DE, U.S.A.)	
Electro-optical properties of thin indium tin oxide films: limitations on performance	281
R. G. Dhere, T. A. Gessert, L. L. Schilling, A. J. Nelson, K. M. Jones, H. Aharoni and T. J. Coutts (Golden, CO, U.S.A.)	
Vacuum growth of thin films of ZnSnP <sub>2</sub> . . . . .	291
P. K. Ajmera, H. Y. Shin and B. Zamanian (Baton Rouge, LA, U.S.A.)	
An approach to the optimal design of p-n heterojunction solar cells using thin film organic semiconductors . . . . .	301
P. Panayotatos, G. Bird, R. Sauers, A. Piechowski and S. Husain (Piscataway, NJ, U.S.A.)	
Measurement of photovoltaic device current as a function of voltage, temperature, intensity and spectrum . . . . .	313
K. Emery and C. Osterwald (Golden, CO, U.S.A.)	
Atmospheric optical calibration system for outdoor photovoltaic measurements	329
R. Hulstrom and T. Cannon (Golden, CO, U.S.A.)	
Joint EPRI-SERI spectral solar radiation database project . . . . .	337
C. Riordan (Golden, CO, U.S.A.)	
Outdoor performance and stability testing of thin film devices . . . . .	343
R. DeBlasio, D. Waddington and L. Mrig (Golden, CO, U.S.A.)	
High speed characterization of photovoltaic devices . . . . .	353
R. K. Ahrenkiel, D. J. Dunlavy (Golden, CO, U.S.A.) and H. C. Hamaker (Palo Alto, CA, U.S.A.)	

Photoreflectance characterization of the space charge region in semiconductors: indium tin oxide on InP as a model system . . . . .	371
R. N. Bhattacharya, H. Shen, P. Parayanthal, F. H. Pollak (Brooklyn, NY, U.S.A.), T. Coutts and H. Aharoni (Golden, CO, U.S.A.)	
Photoluminescence in polycrystalline CuInSe <sub>2</sub> solar cells . . . . .	379
J. R. Sites and R. E. Hollingsworth (Fort Collins, CO, U.S.A.)	
<b>FUNDAMENTAL STUDIES ON NEW MATERIALS AND STABILITY</b>	
Bonding defects in amorphous silicon alloys . . . . .	387
J. W. Cook, Jr., G. N. Parsons, C. Kusano and G. Lucovsky (Raleigh, NC, U.S.A.)	
Ohmic contacts and doping of CdTe . . . . .	399
A. L. Fahrenbruch (Stanford, CA, U.S.A.)	
New approaches for high efficiency cascade solar cells . . . . .	413
T. Katsuyama, M. A. Tischler, D. Moore, N. Hamaguchi, N. A. Elmasry and S. M. Bedair (Raleigh, NC, U.S.A.)	
Metastability of hydrogenated amorphous silicon . . . . .	419
J. I. Pankove (Boulder, CO, U.S.A.)	
Effects of dopant and impurity incorporation on metastable light-induced defect formation . . . . .	431
W. B. Jackson, M. Stutzmann and C. C. Tsai (Palo Alto, CA, U.S.A.)	
Theoretical investigations of the light-induced effects in hydrogenated amorphous silicon . . . . .	439
D. Adler (Cambridge, MA, U.S.A.)	
<b>ABSTRACTS</b>	
Photovoltaics research and development — key to America's energy source . . . . .	449
J. L. Stone (Golden, CO, U.S.A.)	
Review of high efficiency multijunction and point contact GaAs solar cell development . . . . .	449
J. A. Hutchby, M. L. Timmons, P. K. Chiang, M. F. Lamorte and G. G. Fountain (Research Triangle Park, NC, U.S.A.)	
Status and directions in high efficiency silicon solar cell research . . . . .	450
A. Rohatgi (Atlanta, GA, U.S.A.)	
Material aspects of multijunction solar cell research . . . . .	450
S. Guha (Troy, MI, U.S.A.)	
GaInP/GaAs multijunction solar cells . . . . .	450
J. M. Olson, A. Kibbler and T. Gessert (Golden, CO, U.S.A.)	
Amorphous alloy tandem junction solar cells . . . . .	451
V. Dalal and J. Booker (Bedford, MA, U.S.A.)	
CdTe/CuInSe <sub>2</sub> multijunction solar cells . . . . .	451
J. D. Meakin, R. W. Birkmire and J. E. Phillips (Newark, DE, U.S.A.)	
Multijunction concentrator solar cells . . . . .	452
J. G. Werthen (Palo Alto, CA, U.S.A.)	
Defects in hydrogenated amorphous silicon and related alloys . . . . .	452
P. C. Taylor, R. Ranganathan, C. Lee, E. D. Vanderheiden and W. D. Ohlsen (Salt Lake City, UT, U.S.A.)	
Photochemical vapor deposition of amorphous silicon and alloys for thin film solar cells . . . . .	453
B. N. Baron, S. S. Hegedus, S. C. Jackson and R. E. Rocheleau (Newark, DE, U.S.A.)	
Study of thermal and light-induced changes in amorphous silicon alloy materials	453
W. J. Collis and S. Iyer (Greensboro, NC, U.S.A.)	
Application of metal-organic chemical vapor deposition techniques to CdTe/ITO thin film solar cells . . . . .	454
D. E. Schafer (Bloomington, MN, U.S.A.)	

<b>CdZnTe for a wide band gap all thin film solar cell.</b>	454
K. A. Hay and K. R. Zanio (Newport Beach, CA, U.S.A.)	
<b>Deep level study of CdS/CuInSe<sub>2</sub> solar cells</b>	454
V. Ramanathan, R. C. Powell, S. K. Deb and R. Noufi (Golden, CO, U.S.A.)	
<b>Junction formation and the role of oxygen in thin film CdS/CuInSe<sub>2</sub> solar cells</b>	455
R. J. Matson and R. Noufi (Golden, CO, U.S.A.)	
<b>The preparation of thin films for photovoltaic conversion by novel metal-organic chemical vapour deposition techniques</b>	455
A. Saunders and A. Vecht (London, U.K.)	
<b>GaAs-based ternary compounds and solar cell research</b>	456
S. M. Vernon, S. P. Tobin and R. G. Wolfson (Bedford, MA, U.S.A.)	
<b><i>In situ</i> optical characterization of structures grown by metal-organic chemical vapor deposition</b>	456
J. M. Olson and A. Kibbler (Golden, CO, U.S.A.)	
<b>Highly efficient silicon solar cells</b>	457
M. B. Spitzer (Bedford, MA, U.S.A.)	
<b>Photovoltaic safety conference</b>	457
W. Luft (Golden, CO, U.S.A.)	
<b>Rapid liquid phase epitaxial growth studies</b>	458
E. E. Crisman, J. T. Daly, H. J. Gerritsen and S. K. F. Karlsson (Providence, RI, U.S.A.)	
<b>Work in the solid state theory group at the Solar Energy Research Institute</b>	458
A. Zunger, S. Froyen, D. Wood, J. Bernard, A.-A. Mbaye and S.-H. Wei (Golden, CO, U.S.A.)	
<b>Light spot scanning of solar cells: a test of the assumption of uniformity</b>	459
J. E. Phillips and S. Damaskinos (Newark, DE, U.S.A.)	
<b>Transmission electron microscopy and scanning electron microscopy characterization of GaP grown by metal-organic chemical vapor deposition on silicon substrates</b>	459
M. M. Al-Jassim (Golden, CO, U.S.A.)	
<b>Electronic structure and stability of semiconductor alloys</b>	460
A. Zunger (Golden, CO, U.S.A.)	
<b>AUTHOR INDEX</b>	461
<b>SUBJECT INDEX</b>	463

